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Refer to: 3-Y-50,596

To: Space Technology Laboratories
One Space Park
Redondo Beach, California

Attn: Titan II Program Office

Subj: Contract AF04(647)-213, CR-63-92 (Rev 1), Post Firing
Captive Test Report, MVE, SM68B-15

Ref: Paragraph 3.11.3 of contractor's specification BMS-TII-
CD-74,000, dated 30 December 1960, SCNs 1 thru 13, as
incorporated in Item 8 of Exhibit A of subject contract
by Exhibit E as a part of AFBM Exhibit 58-1

Encl: CR-63-92 (Rev 1)

1. In accordance with contractual requirements of the a-
bove reference, copies of the subject document are transmitted
herewith.

Very truly yours,

MARTIN COMPANY

L. A. Kuney
L. A. Kuney, Supervisor
Contractual Data Control

LAK:PE:pb

Letter only to:

A. Hawkins, A-263
R. Chandler, A-195
A. H. Bauman, A-18
CCC, A-45
Originator, A-390
W. Dolin, A-337

Bureau of the Budget
Approval No. 21-R138.1

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THE AEROSPAC
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POST FIRING CAPTIVE TEST REPORT
Rev. 1

Missile SM68B-15
Missile Verification Firing
CR-63-92

1.0 INTRODUCTION

- 0 1.1 This is a summary of Missile Verification Firing (MVF) of Missile B-15 performed by the Martin Company at the Denver Test Stand D-2 in accordance with Test Directive MVF B-15.

2.0 MISSILE CHECKOUT AND MVF DESCRIPTION

2.1 Missile Configuration

Missile B-15 contained the first IRSS to be tested during an MVF. This required a close data reduction operation between Martin and A.C. Spark Plug. All T.M. data was played back by A.C. Spark Plug due to the format deviations between the PCM TM systems. This contributed to the instrumentation checkout and data reduction problems encountered on this missile.

The A.C. Spark Plug guidance system was simulated.

Airborne batteries were used for the MVF.

2.2 Chronological History

Missile B-15 was received and erected on Test Stand D-2 21 February 1963. Power application was delayed due to GSE marriage cable incompatibility. This problem was corrected and power applied 23 February 1963. IRSS operations required marriage cable connectors different than the R&D instrumentation system.

The airborne hydraulic system was filled, flushed and sealed 23 February 1963.

The initial MFL checkout was attempted 23 February 1963. The MFL run was unsuccessful due to bad autopilot gain signals. This problem was traced to Modification 30 7182-05 which resulted in a continuous ground on the gain change relay through the airborne I.G.S. test cable. The test cable was modified to be compatible with the airborne wiring. (Note: A.C. Spark Plug guidance system is simulated during missile verification firings).

The instrumentation system experienced an excessive voltage drop between missile stages caused by "line loss" in the marriage cables. New cables were fabricated and installed which corrected this condition. This condition was peculiar to the IRSS requirements.

All systems were ready for a CST (Combined System Test) with the exception of IRSS instrumentation 26 February 1963. A "dry" CST was conducted but was unsuccessful due to an "Activate Batteries" hold. The problem was traced to a mistermination in the missile wiring. The wiring was corrected and a successful "dry" CST was completed 28 February 1963. Wire was located on the correct terminal board but was one terminal removed from the correct position. This wiring error was created during missile modifications.

Phase 01 procedures (checkout) were completed and an official CST conducted 1 March 1963. The CST was unsuccessful due to problems with the IRSS. A.C. Spark Plug could not play the data tape on recorders due to synchronization problems. The A.C. Spark Plug multiplexer was removed and delivered to the A.C. Spark Plug Laboratory for checkout. The multiplexer checked out satisfactorily and was reinstalled in the missile. The synchronization problem was determined to be instrumentation ground station set up problem.

The Stage II hydraulic pump was replaced 4 March 1962 due to excessive leakage. The hydraulic system was pressure checked, bled and sealed. During the subsequent MFL checkout the autopilot appeared defective; however, this indication was erratic and the problem could not be located. Three MFL chassis (2301, 2302 and 2303) were removed and returned to the laboratory for a bench check. Chassis C/P 2301 and 2302 checked out as good. The following problems were found and corrected on C/P 2303:

- (1) One wire missing
- (2) Connector was not slotted deep enough to make positive contact.
- (3) Defective diode.

The above chassis were reinstalled and two MFL runs were conducted with no problems.

The Stage I gas generators were removed 4 March 1963 and returned to Aerojet Sacramento for inspection and rework (deburring inspection). Due to the extensive delay required for inspection and rework, the Stage I gas generators were robbed from Missile N-17 and received at Martin-Denver 9 March 1963. The gas generators were installed and required that an engine retest be performed.

A second CST was performed 6 March 1963. This was a confidence CST since it was performed during the absence of the Stage I gas generators. Minor problems were encountered and were repaired. These problems were instrumentation ground station set up errors.

The third CST was conducted 11 March 1963. This CST was unsuccessful due to the 5 VDC and 10 VDC instrumentation power supplied reading low. Several (approx. 12) other measurements were also out of tolerance. These problems did not reoccur during several trial runs and extensive troubleshooting.

A fourth CST was conducted 12 March 1963. This CST was unsuccessful due to the following:

- (1) Erratic fire switch indications caused by low timing amplification. The timing amplifier output was increased to resolve this problem.
- (2) A "hold" was received at T-09 sec. due to the missile power returning to ground power. This problem was caused by a guidance "hold" due to a defective booster actuator (actuator was drifting excessively).

The booster actuator was replaced and the hydraulic system was filled, flushed, bled and sealed on 13 March 1963.

The instrumentation power supplies (5 VDC and 10 VDC) low voltage problem reappeared during this CST. After extensive troubleshooting, the A.C. Spark Plug multiplexer was rejected. A bench test was performed and the multiplexer operated intermittently after being in operation for approximately two hours.

A spare multiplexer was not available. A new unit was requested from A.C. Spark Plug, Milwaukee, Wisconsin. This unit arrived at Martin-Denver 15 March 1963, was installed and instrumentation checkout performed.

A final CST was performed on 15 March 1963; data review indicated no major problems.

Ordnance installation was delayed due to interference problems:

- (1) The Stage I S/A #2 oxidizer pre valve squibs could not be installed due to interference with a hydraulic line. The pre valve was retorted to correct this problem. Procedures were modified to add pre valve "clocking".
- (2) The Stage II start cartridge could not be connected electrically because the A.G.C. conduit was not "clocked" properly. The conduit was reclocked and leak checked.

Ordnance installation and propellant loading were completed 18 March 1963.

The MVF was delayed due to the PCM-FM transmitter failing prior to countdown (loss of power output). The unit was replaced and retested.

The MVF countdown was picked up at 13:56, 19 March 1963. A "hold" was encountered at T-1:26 due to erratic timing. The decision to proceed with the count was made at this time since the timing malfunction was of a minor nature.

The count was picked up the second time at 15:26 hrs. A "hold" was encountered at T-2:04 due to an indication that Stage I oxidizer flight pressure valve was not closed. This problem was found to be an erroneous indication.

The count was picked up the third time at 15:41 hrs. A "hold" was encountered at T-0:23 sec. due to erratic 10 FPS timing. The MVF attempt was "scrubbed" at this time to correct the timing problems. All pre valves were opened and the batteries activated during this MVF attempt.

The Stage II fuel was off-loaded as a safety measure and the A/B batteries replaced. Fuel was reloaded 19 March 1963.

The timing problem was traced to the range timing cable shield being "open" between the blockhouse and the Central Support Building. It was felt this problem occurred due to excessively high winds prior to the MVF attempt. This problem was corrected by grounding the shield in the blockhouse.

Prior to the MVF attempt on 20 March 1963, a MFL run was conducted and a "Ready to Launch" light was not received. Troubleshooting revealed an intermittent wire (ground) between the equipment room and umbilical tower. A spare wire was substituted.

The second MVP attempt was conducted 20 March 1963. The countdown was successful and 87FSI occurred at 13:26:18.2 hrs. Both stages ran the scheduled 20 seconds. The "Quick Look" meeting was held 21 March 1963 and resulted in the following action items:

A. Problem

During countdown the Stage I oxidizer flight pressure valve failed to indicate "closed" condition. Investigation at this time revealed that the valve was actually closed but the "closed" microswitch was not actuated. Subsequent cycling of the flight pressure valve apparently freed the switch and eliminated the problem for this firing.

Action Item

Investigate "sticky" microswitch problem as pertaining to all pressurization and vent valves.

Report:

This problem is due to a poorly designed microswitch in the Vacco Valve which results in the microswitch sticking. The engineering fix is a modification to the present Skyvalves and replacement of all Vacco Valves at Test Stand D-2 with modified Skyvalves. This modification is in progress and is scheduled for installation by 15 April 1963.

B. Problem

The Telemetry transmitter failed prior to starting the first countdown. Also, two TM transmitters failed during VTF testing of this missile.

Action Item

Investigate and determine reason for TM package failures.

Report

The TM transmitter failures have been due to low power output. This failure has been traced to bad filaments in the power amplifier tube 84K1. A meeting to resolve the problem of the power amplifier tubes in all packages is scheduled for 28 March 1963 with the Special Action Group and Technical Procurement.

C. Problem

Measurement 175 (Po-1) was lost during the firing.

Action Item

1. Using data available, reconstruct S/A #1 engine firing. Verify with computer satisfactory engine performance below the TPA.
2. Inspect S/A #1 engine for evidence of damage.

Report

1. Po-1 (measurement 175) did not play during the firing. Therefore, there is no accurate method to determine engine performance. Based upon other parameters, tank top pressures, discharge pressures, turbine speeds, etc. and an engine inspection, S/A #1 appears to have operated satisfactorily. An AGC computer run confirms that performance was within 3% of expected values.

2. A visual inspection revealed no damage to the S/A #1 engine.

D. Problem

The following instrumentation discrepancies were noted:

<u>Measurements</u>	<u>Discrepancies</u>
0175 (Po-1)	No data
0176 (Po-2)	High reading
2078 (TTi-1)	High reading
3451 (Fire Detector)	No data

Action Item

1. Investigate and resolve.
2. If measurement 2078 (TTi-1) is verified to be above 1700°F it will be necessary to inspect S/A #1 turbine for heat damage.

Report

1. (a) Meas. 0175 (Po-1) Problem found to be a defective A/B cable (P/N 804F1050113-009). Cable replaced. Cable is located between marriage cable and Aerojet interface on Stage I.
- (b) Meas. 0176 (Po-2) Measurement data and calibration was checked; no discrepancy was found. Data indicates pressure of 785 BSIA which is within tolerance specified by E.T.O.
- (c) Meas. 2078 (TTi-1) A corrected data stick shows TTi-1 reading 1717°F. A error of 11°F was found in system calibration. Final reading of TTi-1 is 1706°F. An inspection was performed on the turbine. No indications of heat damage was found.
- (d) Meas. 3451 (Fire Detector) Loss of data on this parameter was caused by a defective V.C.O. unit. Defective unit was replaced.

A telemetry radiation (frequency) test was performed on 22 March 1963.

The missile was cleaned and de-erection was completed 24 March 1963.

3.0 TEST OBJECTIVES

The test objectives specified in ETO MVP-B and the degree to which they were accomplished are listed below:

3.1 Primary Objectives

3.1.1 Demonstrate proper operation and compatability of the complete missile system with OGE under a firing environment, within the capabilities of the Denver Test Area.

3.1.1.1 During preparation for the second MVP countdown, the MFL Ready to Launch light would not operate. Troubleshooting revealed an inter-connecting wire shorted to ground. A spare wire was terminated and the shorted wire spared. This wire is installed in conduit between the Transfer Room and the Umbilical tower.

With the exception of the above item, all automatic checkouts, countdown and firing were completed without holds or malfunctions generated by the O.G.E.

Objective was satisfactorily met.

3.1.2 Verify adequate manufacturing quality of the operational missile.

3.1.2.1 Manufacturing Quality of the missile was adequate throughout the firing.

Objective was satisfactorily met.

3.1.3 Provide problem information covering all aspects of missile and OGE checkout and operation, so that problems can be identified and action can be initiated to resolve them at the earliest possible point in the program.

3.1.3.1 Trouble Reports and Failure Reports were prepared as necessary. Test Stand personnel have submitted the formal Problem Summary Report.

3.1.4 Verify adequate manufacturing quality of the airframe to support missile firings and to withstand the hot firing environment.

3 3.1.4.1 Post firing inspections and leak checks substantiate the fact that planned firing duration was achieved without leakage of propellant tanks or associated lines or material failure of the basic structure.

Objective was met.

3.1.5 Verify that the quality and performance of the engines are in no way degraded (by processes and procedures performed after engine acceptance tests).

3.1.5.1 The following engine parameters were not within limits as specified in ETO MVP-B. Waivers were obtained for these measurements:

Measurement	Parameter
2078	TTI-1
0175	Pc-1

Measurement 2078 (TTI-1) spiked in excess of 1750°F during shutdown. An inspection was conducted of the turbine. No damage was found.

Measurement 0175 (Pc-1) did not record during the MVP. A defective airborne cable (P/N 804F1050113-009) was found to be the cause. This cable was replaced as a quick look action item.

The Stage I (sub-assembly #1) engine performance, based on other parameters, tank top pressures, discharge pressures, turbine speeds, etc. and an engine inspection, appears to have operated satisfactorily. An AGC computer run confirms that performance was within 3% of expected values. The other engines performed within specified limits.

Objective was met.

3.1.6 Verify that manufacturing quality of the missile propellant feed and autogenous pressurisation subsystem meet design requirements.

3.1.6.1 The propellant feed system and the autogenous pressurization system met all objectives during the missile verification firing of Missile B-15.

3.1.7 Verify proper operation of the flight control subsystem under firing conditions.

3.1.7.1 The actuator gimbaling occurred as planned. All flight control parameters remained within limits as specified in ETO MVF-B.

3.1.8 Demonstrate the functional compatibility of the OGE with the missile.

3.1.8.1 All automatic checkouts, countdown and firing were completed without holds or malfunctions caused by OGE incompatibility.

3.1.9 Demonstrate proper operation and compatibility of the IRSS with all other missile systems, except guidance, under a firing environment.

3.1.9.1 Data obtained during the firing from the IRSS was very good. Two parameters (Po-1 and TTi-1) were questionable during data review (see 3.1.5.1). The tracking and flight safety systems performed satisfactorily during the MVF.

Objective was met.

3.1.10 Verify satisfactory activation and operation of airborne batteries.

3.1.10.1 The activation and operation of the airborne batteries was satisfactory throughout the MVF.

The objective was met.

3.1.11 Verify satisfactory operation of the missile electrical system during MVF operation.

3.1.11.1 No major problem areas were seen during the pre-launch countdown and subsequent captive firing. APS and IRSS batteries were pre-loaded and transferred to the missile busses as planned. The VHPS battery is not pre-loaded and did function normally.

The airborne electrical system functioned as planned. All voltage parameters were maintained within specification limits for the duration of the test.

4.0 SECONDARY OBJECTIVE

4.1 Obtain data for use in determining missile reliability.

4.1.1 Trouble reports, failure reports, problem reports and test stand operation records have been submitted for missile reliability study.

5.0 CONCLUSIONS

5.1 The MVF of Missile B-15 was successful.


5.2 The IRSS operation during Missile B-15 MVF performed satisfactorily.

The extremely close co-ordination between Martin and A.C. Spark Plug required for missile checkout and MVF operation delayed to some extent the MVF schedule.

5.3 The airborne missile batteries operated extremely well. Two sets were used and all batteries activated with no problems encountered. The following types were used:

APS Battery	PD94S0008-011
IRSS Battery	PD94S0008-013
VHPS Battery	PD94S0009-007

5.4 Propellants remained on Missile B-15 with the prevalues opened for approximately a twenty-four hour period. No propellant leakage was observed downstream of the engine thrust chamber valves.


H. Campbell
Test Surveillance
Test Department